PURDUE
UNIVERSITY

DEPARTMENT OF BIOCHEMISTRY & DEPARTMENT OF CHEMISTRY

BCHM 62100/CHM69600
Biological Mass Spectrometry, Proteomics and Metabolomics
CRN: 35423/39008
Spring 2026

COURSE OBJECTIVES

This is a three-credit course. The goals of this course are to introduce students to

1) Basic principles of biological mass spectrometry, proteomics and metabolomics;
2) Common instruments used for biological mass spectrometry;
3) The skills necessary to analyze mass spec data from a variety of experiment types including the ability to use and understand common database search programs;
5) Quantitative mass spectrometry and their use in proteomic and metabolomics studies;
6) Applications of proteomics and metabolomics in biological research;
7) Contemporary issues associated with large-scale proteomics and metabolomics experiments (including technical challenges and limitations) culminating in the ability to design appropriate experiments to answer a specific omics question.

COURSE LEARNING OUTCOMES

Students will be knowledgeable in practical skills associated with mass spectral analysis of biological molecules, with a heavy emphasis on proteins/peptides.

Students will understand the basics of experimental design for the mass spectral analysis of proteins and metabolites.

Students will acquire an appreciation for current instrumentation and methods commonly used in biological mass spectrometry and the advantages and disadvantages of each.

Students will be able to read and critically evaluate primary literature pertaining to proteomic and metabolomic studies.

TEXTBOOK

There is no textbook for this course. Assigned reading material will be provided via the course Brightspace page (see below).

BRIGHTSPACE

The syllabus for the course, lecture notes, and grading keys for quizzes and exams will be available via the Purdue University Brightspace site at: https://purdue.brightspace.com

ASSESSMENT

Exams:
There will be one in-class exam and one final exam. The final exam will be based on the completion of a proteomics/metabolomics project using cloud-based data analysis.

Homework:
Virtual quiz will be posted on the Brightspace site to guide and motivate the study. There will be 5-6 homework assignments for the course.

Grading Scale:
- In-class and final exam will count 60% of the final grade, respectively.
- Homework sets collectively will count for 30% of the final grade.
- Attendance and in-class discussion will count 10% of the final grade, which includes class participation, discussion and **seminars**.

The following grading scale will be used:

92-100 = A
90-91 = A-
88-89 = B+
82-87 = B
80-81 = B-
78-79 = C+
72-77 = C
70-71 = C-
60-69 = D
below 60 = F

I reserve the right to apply grading curves to any of the tests and homework sets but there will not automatically be a defined curve.

Missing a homework assignment will result in a grade of 0 being recorded unless documented justification is presented.

If you have any disagreements with the way any of your assignments have been graded, please make an appointment to see the instructor.

Requests for re-grades must be submitted no later than the end of the second class period after the grade is received.

EXTRA CREDIT

There will be no opportunity for extra credit.

OBTAINING EXTRA HELP

The instructor will be available to answer questions immediately after class or by appointment (arranged in class or by e-mail). Alternatively, you can submit questions by e-mail.

ON-LINE COURSE EVALUATIONS

During the last two weeks of the semester, you will be provided an opportunity to evaluate this course and your instructor. Purdue now uses online course evaluations. At the end of the semester you will receive an official email from evaluation administrators with a link to the online evaluation site. You will have a couple weeks to complete this evaluation. Your participation in this evaluation is an integral part of this course. Your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

ACADEMIC INTEGRITY

The Purdue Honors Pledge:

All students in the course are expected to behave in a manner consistent with the Purdue Honors Pledge:
https://www.purdue.edu/provost/teachinglearning/honor-pledge.html
"As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breeches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

To provide you with an unambiguous definition of academic misconduct, the following text has been excerpted from "Academic Integrity: A Guide for Students", written by Stephen Akers, Ph.D., Executive Associate Dean of Students (1995, Revised 1999, 2003), and published by the Office of the Dean of Students in cooperation with Purdue Student Government, Schleman Hall of Student Services, Room 207, 475 Stadium Mall Drive West Lafayette, IN 47907-2050.

“Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, *University Regulations*] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

More specifically, the following are a few examples of academic dishonesty which have been discovered at Purdue University.

- substituting on an exam for another student
- substituting in a course for another student
- paying someone else to write a paper and submitting it as one's own work
- giving or receiving answers by use of signals during an exam
- copying with or without the other person's knowledge during an exam
- doing class assignments for someone else
- plagiarizing published material, class assignments, or lab reports
- turning in a paper that has been purchased from a commercial research firm or obtained from the internet
- padding items of a bibliography
- obtaining an unauthorized copy of a test in advance of its scheduled administration
- using unauthorized notes during an exam
- collaborating with other students on assignments when it is not allowed
- obtaining a test from the exam site, completing and submitting it later
- altering answers on a scored test and submitting it for a regrade
- accessing and altering grade records
- stealing class assignments from other students and submitting them as one's own
- fabricating data
- destroying or stealing the work of other students

Plagiarism is a special kind of academic dishonesty in which one person steals another person's ideas or words and falsely presents them as the plagiarist's own product. This is most likely to occur in the following ways:

- using the exact language of someone else without the use of quotation marks and without giving proper credit to the author
- presenting the sequence of ideas or arranging the material of someone else even though such is expressed in one's own words, without giving appropriate acknowledgment
- submitting a document written by someone else but representing it as one's own

Course Policy Towards Academic Misconduct: Any incidence of academic misconduct on an individual assignment, including but not necessarily limited to

the examples above, will result in a grade of 0 on that assignment and will be reported to the Purdue Office of Student Rights and Responsibilities for evaluation and possibly more extensive disciplinary action.

NOTICE OF COPYRIGHT PROTECTION OF COURSE MATERIALS

Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

EMERGENCY PREPAREDNESS

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Non-DISCRIMINATION POLICY

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue's nondiscrimination policy can be found at: https://www.purdue.edu/home/ea_eou_statement/

MENTAL HEALTH/WELLNESS STATEMENT:

Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should

contact Counseling and Psychological Services (CAPS) at (765)494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.

Please also make note of Therapy Assistance Online (TAO), a web and app-based mental health resource available courtesy of CAPS. A link to it is included under the Health and Well-Being Resources of the Student widget on the Brightspace homepage. TAO is available to students, faculty, and staff at any time by creating an account on the TAO Connect website, or downloading the app from the App Store or Google Play. It offers free, confidential well-being resources through a self-guided program informed by psychotherapy research and strategies that help overcome anxiety, depression and other concerns. It provides accessible and effective resources including short videos, brief exercises and self-reflection tools. See the CAPS TAO webpage for more details and a Q&A.

Student of concern reporting (anyone at Purdue may submit a report if they are unsure where to go or in what way they can help a student - it does not need to be an emergency).

ACCESSIBILITY AND ACCOMODATIONS

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

DISCLAIMER

This syllabus is subject to change.

COURSE SCHEDULE

CLASS 1
Introduction: Understanding the mass spectrum; Basic principles of MS; Proteomics and Metabolomics

CLASS 2
MS instrumentation (I):
– ionization sources
– mass analyzers

CLASS 3
MS instrumentation (II):
– tandem mass spectrometry
– ion mobility
– Interface to liquid chromatography

CLASS 4
– Peptide ion fragmentation
– Generating peptides for MS analysis

CLASS 5
Bottom-up Proteomics:
– peptide mass fingerprinting and database search algorithms
– de novo sequencing of peptides

CLASS 6
Protein MS applications
– identification of post-translational modifications from tandem MS data
– tools for scoring PTM assignments, focusing on protein phosphorylation

CLASS 7
Quantitative MS
– Absolute and relative quantification of biomolecules using stable isotope labeling
– Label-free approaches to quantification of biomolecules

CLASS 8
Top-down proteomics

CLASS 9
DIA: Data-independent acquisition
Proteomics Bioinformatics tools

CLASS 10
Metabolomics: Instrumentation and sample preparation

CLASS 11
– Targeted and untargeted metabolomics
– Metabolomics bioinformatics tools

CLASS 12
Lipidomics, MS imaging, and metabolomics bioinformatics tools

CLASS 13
In-class exam

CLASS 14-15
Critical literature reading and in-class discussion

FINAL PROJECT
– **cloud-based computation and data analysis**
– **last four weeks of the semester**